housing 120 is shown in FIG. 6.

In FIG. 6, the shaft sealing apparatus 200 comprises a driving shaft 240 in the form of a cylindrical shape and received in the shaft housing 120, not shown, to be movably supported by the shaft housing 120. The driving shaft 240 is held in coaxial alignment with the shaft housing 120 and rotatable around its own axis with respect to the shaft housing 120. The driving shaft 240 has a first axial end 240a extending in the vacuum chamber 111 of the vacuum casing 110, a second axial end, not shown, extending in the atmosphere 112, and an outer cylindrical surface 240b smaller in diameter than the inner cylindrical surface 120a of the shaft housing 120.

The shaft sealing apparatus 200 further comprises a sealing unit 260 received in the opening 110b of the vacuum casing 110 and fixedly supported by the base portion 110a of the vacuum casing 110. The sealing unit 260 includes a retaining member 161 and a plurality of sealing rings 163. Each of the sealing rings 163 of the sealing unit 260 intervenes between the driving shaft 240 and the retaining member 161 of the sealing unit 260 to hermetically seal the gap between the driving shaft 240 and the retaining member 161 of the sealing unit 260. The sealing rings 163 of the sealing unit 260 are held in axially spaced-apart relationship with each other. The retaining member 161 of the sealing unit 260 has an inner cylindrical surface 161c larger in diameter than the outer cylindrical surface 240b of the driving shaft 240. The sealing lip 164c of the annular resilient member 164 is held in contact with the outer cylindrical surface 240b of the driving shaft 240. The annular spring member 165 of the sealing ring 163 is operative to impart a force to the sealing lip 164c of the annular resilient member 164 to ensure that the sealing lip 164c of the annular resilient member 164 is held in tight contact with the outer cylindrical surface 240b of the driving shaft 240.

In the second embodiment of the shaft sealing apparatus according to the present invention, the outer cylindrical surface 240b of the driving shaft 240 is smaller in surface roughness Ra than 0.1 μ m, and larger in Vickers hardness Hv than 650.

The shaft sealing apparatus 200 further comprises a fixed member 280 in the form of an annular ring shape and provided on the retaining member 161 of the sealing unit 260. The fixed member 280 is fixedly connected with the retaining member 161 of the sealing unit 260 by bolts 281.

The above description of the second embodiment has been made only about the driving shaft 240, the sealing unit 260 and the fixed member 280 different from those of the first embodiment, but has not been directed to the vacuum casing 110, the shaft housing 120, the retaining member 161, the sealing ring 163 and the base member 190 which are entirely the same as those of the first embodiment. Detailed

description about the vacuum casing 110, the shaft housing 120, the retaining member 161, the sealing ring 163 and the base member 190 will therefore be omitted hereinafter.

The following description will be directed to a method of assembling the shaft sealing apparatus 200 with reference to the drawings shown in FIG. 6. The method of assembling the shaft sealing apparatus 200 is performed through the steps including a preparing step and first and second installing steps as follows.

In the preparing step, the vacuum casing 110, the shaft housing 120, the driving shaft 240 are prepared as a partially assembled unit. The construction of the driving shaft 240 has been described in the above.

In the first installing step, the sealing unit 260 constituted by the retaining member 161 and the sealing rings 163 securely retained by the retaining member 161 is installed in the opening 110b of the vacuum casing 110. The construction of the sealing unit 260 has been described in the above.

In the second installing step, the fixed member 280 is installed on the retaining member 161 of the sealing unit 260. The construction of the fixed member 280 has been described in the above. The shaft sealing apparatus 200 is then assembled as shown in FIG. 6.

It is understood that the second embodiment of the shaft sealing apparatus according to the present invention has an advantage and effect the same as that of the first embodiment of the shaft sealing apparatus according to the present invention.

Referring now to the drawings, in particular to FIG. 7, there is shown the third preferred embodiment of the shaft sealing apparatus according to the present invention. The shaft sealing apparatus 300 is available for a vacuum processing apparatus equipped with a handling mechanism. The shaft sealing apparatus 300 comprises a vacuum casing 310 formed with a vacuum chamber 311, and a shaft housing 320 in the form of a cylindrical hollow shape and fixedly connected with the vacuum casing 310. The vacuum casing 310 has a base portion 310a formed with an opening 310b to have the vacuum chamber 311 of the vacuum casing 310 held in communication with the atmosphere 312 through the opening 310b of the vacuum casing 310.

The shaft housing 320 has a first axial end 320a extending in the vacuum chamber 311 of the vacuum casing 310, a second axial end, not shown, extending in the atmosphere 312, a flange portion 320b integrally formed with the first axial end 320a and radially outwardly extending from the first axial end 320a, and an inner cylindrical surface 320c formed with an annular ledge 320d connected with the first axial end 320a. The flange portion 320b of the shaft housing 320 is fixedly

connected with the base portion 310a of the vacuum casing 310 by bolts 321. Each of the first axial end 320a of the shaft housing 320 and the flange portion 320b of the shaft housing 320 is exposed to the vacuum chamber 311 of the vacuum casing 310 to form part of the base portion 310a of the vacuum casing 310.

The shaft sealing apparatus 300 further comprises a sleeve shaft 330 in the form of a cylindrical hollow shape and received in the shaft housing 320 to be movably supported by the shaft housing 320. The sleeve shaft 330 is held in coaxial alignment with the shaft housing 320 and rotatable around its own axis with respect to the shaft housing 320. The sleeve shaft 330 has a first axial end 330a extending in the vacuum chamber 311 of the vacuum casing 310, a second axial end, not shown, extending in the atmosphere 312, an outer cylindrical surface 330b smaller in diameter than the inner cylindrical surface 320c of the shaft housing 320, and an inner cylindrical surface 330c formed with an annular ledge 330d connected with the first axial end 330a. The sleeve shaft 330 constitutes a driving shaft having an outer cylindrical surface and movably extending in the vacuum chamber 311 of the vacuum casing 312.

While the shaft sealing apparatus 300 has been described in the above as comprising a sleeve shaft 330 rotatable around its own axis with respect to the shaft housing 320, the sleeve shaft 330 may be replaced by a sleeve shaft axially movable along its own axis with respect to said shaft housing 320 according to the present invention.

Though the shaft sealing apparatus 300 has been described in the above as comprising a sleeve shaft 330 in the form of a cylindrical hollow shape and received in the shaft housing 320 to be held in coaxial alignment with the shaft housing 320, the sleeve shaft 330 may be replaced by a plurality of sleeve shafts each in the form of a cylindrical hollow shape and received in the shaft housing 320 to be held in coaxial alignment with the shaft housing 320 according to the present invention.

The shaft sealing apparatus 300 further comprises a center shaft 340 in the form of a cylindrical shape and received in the sleeve shaft 330 to be movably supported by the sleeve shaft 330. The center shaft 340 is held in coaxial alignment with the sleeve shaft 330 and rotatable around its own axis with respect to the sleeve shaft 330. The center shaft 340 has a first axial end 340a extending in the vacuum chamber 311 of the vacuum casing 310, a second axial end, not shown, extending in the atmosphere 312, and an outer cylindrical surface 340b smaller in diameter than the inner cylindrical surface 330c of the sleeve shaft 330. The center shaft 340 constitutes a driving shaft having an outer cylindrical surface and movably extending in the vacuum chamber 311 of the vacuum casing 312.